Claims

[c1] 1.An apparatus for use in an optical fiber hydrophone module for transitioning optical fiber between components of the module, the module having a central axis and comprising an optical hydrophone assembly, the hydrophone assembly comprising a plurality of mandrels helically wrapped with optical fiber and connected in linear relation with interconnect springs, each interconnect spring having an interior surface that defines a cylindrical void and an exterior surface having a helical groove that receives the optical fiber, the optical hydrophone assembly terminatingwith an interconnect spring, the fiber transitioning apparatus comprising:

a conical, elongated element having first and second ends, the first end adapted to be connected to the hydrophone assembly, and having a helical groove for receiving the optical fiber from the assembly so that the fiber transitions to the central axis of the module.

[c2] 2.A fiber transitioning apparatus as recited in claim 1, wherein the element is adapted to be mounted to the terminal interconnect spring.

[c3] 3. A fiber transitioning apparatus as recited in claim 1, wherein the pitch of the helical groove in the element approximately matches the pitch of the groove in the interconnect spring.

[c4] 4.A fiber transitioning apparatus as recited in claim 2, wherein the element comprises a cylindrical insert and a conical body, the conical body having a wide end and a narrow end, the wide end proximate to the first end of the element and the narrow end being the second end of the

element, the cylindrical insert in axial alignment with and reciprocally mounted in the wide end of the conical body, the cylindrical insert extending longitudinally outside of the conical body at the wide end of the conical body, and the portion of the cylindrical insert that extends outside of the conical body is adapted to be reciprocally mounted to the interior surface of the interconnect spring.

[c5] 5.A fiber transitioning apparatus as recited in claim 4, wherein the cylindrical insert is made of polycarbonate resin.

[c6] 6.A fiber transitioning apparatus as recited in claim 4, wherein the conical body is made of polyurethane.

[c7] 7.A fiber transitioning apparatus as recited in claim 6, wherein the polyurethane is approximately 90-A durometer polyurethane.

[c8] 8.A fiber transitioning apparatus as recited in claim 1, wherein starting from the end of the conical body the bare optical fiber is wrapped for two to three revolutions in the helical groove around the conical body.

[c9] 9.A fiber transitioning apparatus as recited in claim 8, wherein the bare fiber is bonded in the helical groove.

[c10] 10.A fiber transitioning apparatus as recited in claim 8, wherein starting from the end of the bare fiber wrapping, the fiber is disposed within a tube that is wrapped for two to three revolutions in the helical groove.

[c11] 11.A fiber transitioning apparatus as recited in claim 10, wherein the tube is made of PTFE.

[c12] 12.A fiber transitioning apparatus as recited in claim 10, wherein the tube is bonded in the helical groove.

[c13] 13.A fiber transitioning apparatus as recited in claim 10, starting from the end of the fiber wrapping with a tube in the helical groove, the helical groove ends and the fiber in the tube is wrapped three to five more revolutions around the conical body before transitioning to the central axis of the module.

[c14] 14.A fiber transitioning apparatus as recited in claim 13, wherein the tube is loosely wrapped around the conical body.

[c15] 15.A fiber transitioning apparatus as recited in claim 3, wherein the optical fiber is wrapped around the conical body within the helical groove in three stages, starting from the end adjacent to the interconnect spring in the first stage for two to three revolutions around the conical body, then in the second stage within a tube, continuing around the conical body within the helical groove for two to three revolutions, and then in the third stage the helical groove ends and the fiber in the tube is wrapped three to five more revolutions around the conical body before transitioning to the central axis of the module.

[c16] 16.A fiber transitioning apparatus as recited in claim 15, wherein the fiber in the first stage is bonded within the helical groove, the tube in the second stage is bonded within the helical groove, and the tube in the third stage is loosely wrapped around the conical body.

[c17] 17.An apparatus for use in an optical fiber hydrophone module for

transitioning optical fiber between components of the module, the module having a central axis and comprising an optical hydrophone assembly, the hydrophone assembly comprising a plurality of mandrels helically wrapped with optical fiber and connected in linear relation with interconnect springs, each interconnect spring having an interior surface that defines a cylindrical void and an exterior surface having a helical groove that receives the optical fiber, the optical hydrophone assembly terminatingwith an interconnect spring, the fiber transitioning apparatus comprising:

a conical, elongated element having first and second ends, the first end adapted to be connected to the hydrophone assembly, and having a helical groove for receiving the optical fiber from the assembly so that the fiber transitions to the central axis of the module, wherein the element is adapted to be mounted to the terminal interconnect spring, and the pitch of the helical groove in the element approximately matches the pitch of the groove in the interconnect spring;

wherein the element comprises a cylindrical insert and a conical body, the conical body having a wide end and a narrow end, the wide end proximate to the first end of the element and the narrow end being the second end of the element, the cylindrical insert in axial alignment with and reciprocally mounted in the wide end of the conical body, the cylindrical insert extending longitudinally outside of the conical body at the wide end of the conical body, and the portion of the cylindrical insert that extends outside of the conical body is adapted to be reciprocally mounted to the interior surface of the interconnect spring.

[c18] 18.An optical fiber hydrophone module having a central axis and

comprising:

an optical hydrophone assembly comprising a plurality of mandrels helically wrapped with optical fiber and connected in linear relation with interconnect springs, each interconnect spring having an interior surface that defines a cylindrical void and a helical groove that receives the optical fiber, the optical hydrophone assembly terminating with an interconnect spring;

a conical, elongated element having first and second ends, the first end adapted to be mounted to the terminal interconnect spring, and having a helical groove for receiving the optical fiber from the assembly so that the fiber transitions to the central axis of the module.

[c19] 19. A fiber transitioning apparatus as recited in claim 18, wherein the pitch of the helical groove in the element approximately matches the pitch of the groove in the interconnect spring.

[c20] 20.A fiber transitioning apparatus as recited in claim 19, wherein the element comprises a cylindrical insert and a conical body, the conical body having a wide end and a narrow end, the wide end proximate to the first end of the element and the narrow end being the second end of the element, the cylindrical insert in axial alignment with and reciprocally mounted in the wide end of the conical body, the cylindrical insert extending longitudinally outside of the conical body at the wide end of the conical body, and the portion of the cylindrical insert that extends outside of the conical body is adapted to be reciprocally mounted to the interior surface of the interconnect spring.

[c21] 21.An optical fiber hydrophone module having a central axis and comprising:

an optical hydrophone assembly comprising a plurality of mandrels helically wrapped with optical fiber and connected in linear relation with interconnect springs, each interconnect spring having an interior surface that defines a cylindrical void and a helical groove that receives the optical fiber, the optical hydrophone assembly terminating with an interconnect spring;

a woven fiber protection cable assembly proximate to the end of the hydrophone assembly, the woven fiber protection cable assembly comprising a woven fiber protection cable generally aligned along the module's central axis,

a conical, elongated element having conical body, a first end, and a second end, with a wide end of the body proximate to the first end of the element and a narrow end of the body being the second end of the element, the first end comprising a cylindrical insert reciprocally mounted to the wide end of the body and to the terminal interconnect spring and having a helical groove for receiving the optical fiber from the assembly so that the fiber transitions to the woven fiber protection cable.

[c22] 22.An optical fiber hydrophone module as recited in claim 21, wherein the pitch of the helical groove in the element approximately matches the pitch of the groove in the interconnect spring.

[c23] 23.A method for transitioning optical fiber between components of an optical fiber hydrophone module, the module having a central axis and comprising an optical hydrophone assembly, the hydrophone assembly

comprising a plurality of mandrels helically wrapped with optical fiber and connected in linear relation with interconnect springs each having an interior surface that defines a cylindrical void and a helical groove that receives the optical fiber, the optical hydrophone assembly terminatingwith an interconnect spring, the steps comprising:

mounting a first end of a conical, elongated element having first and second ends to the hydrophone assembly, wherein the element comprises a cylindrical insert and a conical body, the conical body having a wide end and a narrow end, the wide end proximate to the wide end of the conical and the narrow end being the second end of the element, the cylindrical insert in axial alignment with and reciprocally mounted in the wide end of the conical body, the cylindrical insert extending longitudinally outside of the conical body at the first end of the element, and the portion of the cylindrical insert that extends outside of the conical body is adapted to be reciprocally mounted to the interior surface of the interconnect spring;

wrapping optical fiber in a helical groove of the element for receiving the optical fiber from the assembly; and

transitioning the fiber to the central axis of the module.